Chapter Thirty-one

BASIC DESIGN CONTROLS

BUREAU OF DESIGN AND ENVIRONMENT MANUAL

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BASIC DESIGN CONTROLS

Road design is predicated on many basic controls that establish the overall objective of the highway facility and identify the basic purpose of the highway project. Chapter 31, in combination with Chapter 43, presents those basic controls that impact road design. Chapter 31 includes a discussion on speed, sight distance, traffic volume controls, non-highway controls (e.g., the driver), project scope of work, and the design exception process. The application of these items to a project will impact all elements of road design.

31-1 DEFINITIONS

31-1.01 Qualifying Words

Many qualifying words are used in road design and in this *Manual*. For consistency and uniformity in the application of various design criteria, the following definitions apply:

1. Shall, require, will, must. A mandatory condition. Designers are obligated to adhere to the criteria and applications presented in this context or to perform the evaluation indicated. For the application of geometric design criteria, this *Manual* limits the use of these words.

2. Should, recommend. An advisory condition. Designers are strongly encouraged to follow the criteria and guidance presented in this context, unless there is reasonable justification not to do so.

3. May, could, can, suggest, consider. A permissive condition. Designers are allowed to apply individual judgment and discretion to the criteria when presented in this context. The decision will be based on a case-by-case assessment.

4. Desirable, preferred. An indication that the designer should make every reasonable effort to meet the criteria and that the designer should only use a "lesser" design after due consideration of the "better" design.

5. Ideal. Indicating a standard of perfection (e.g., traffic capacity under "ideal" conditions).

6. Minimum, maximum, upper, lower (limits). Representative of generally accepted limits within the design community but not necessarily suggesting that these limits are inviolable. However, where the criteria presented in this context will not be met, the designer will in many cases need approval.

7. Practical, feasible, cost-effective, reasonable. Advising the designer that the decision to apply the design criteria should be based on a subjective analysis of the anticipated

benefits and costs associated with the impacts of the decision. No formal analysis (e.g., cost-effectiveness analysis) is intended, unless otherwise stated.

8. Possible. Indicating that which can be accomplished. Because of its rather restrictive implication, this word is rarely used in this *Manual* for the application of design criteria.

9. Significant, major. Indicating that the consequences from a given action are obvious to most observers and, in many cases, can be readily measured.

10. Insignificant, minor. Indicating that the consequences from a given action are relatively small and not an important factor in the decision-making for road design.

11. Warranted, justified. Indicating that some well-accepted threshold or set of conditions has been met. As used in this *Manual*, “warranted” or “justified” may apply to either objective or subjective evaluations. Note that, once the warranting threshold has been met, this is an indication that the design treatment should be considered and evaluated – not that the design treatment is automatically required.

12. Standard. Indicating a design value that cannot be violated without severe consequences. This suggestion is generally inconsistent with geometric design criteria. Therefore, “standard” will not be used in this *Manual* to apply to geometric design criteria.

13. Guideline. Indicating a design value that establishes an approximate threshold which should be met if considered practical.

14. Criteria. A term typically used to apply to design values, usually with no suggestion on the criticality of the design value. Because of its basically neutral implication, this *Manual* frequently uses “criteria” to refer to the design values presented.

15. Typical. Indicating a design practice that is most often used in application and which is likely to be the “best” treatment at a given site.

16. Target. If practical, criteria the designer should be striving to meet. However, not meeting these criteria will typically not require a justification.

17. Acceptable. Design criteria that may not meet desirable values, but yet is considered to be reasonable and safe for design purposes.

18. Policy. Indicating IDOT practice which the Department generally expects the designer to follow, unless otherwise justified.

31-1.02 Acronyms

The following are acronyms for common terminology, agencies, and publications used in road design:

- AASHTO. American Association of State Highway and Transportation Officials.
- CFR. Code of Federal Regulations.
- FEMA. Federal Emergency Management Agency.
- FHWA. Federal Highway Administration.
- HCM. *Highway Capacity Manual*.
- IDOT. Illinois Department of Transportation.
- ITE. Institute of Transportation Engineers.
- ISTEA. *Intermodal Surface Transportation Efficiency Act* of 1991.
- MAPS – 21. Moving Ahead for Progress in the 21st Century Act.
- MUTCD. *Manual of Uniform Traffic Control Devices*.
- NCHRP. National Cooperative Highway Research Program.
- NHS. National Highway System.
- SAFETEA-LU. *Safe, Accountable, Flexible, Efficient Transportation Equity Act — Legacy for Users*.
- STP. Surface Transportation Program.
- TEA-21. *Transportation Equity Act* for the 21st Century.
- TRB. Transportation Research Board.
- TRR. Transportation Research Record.
- USC. United States Code.
- USDOT. United States Department of Transportation.

31-2 SPEED

31-2.01 Definitions

1. Design Speed. Design speed is a selected speed used to determine the various geometric design features of the roadway. A design speed is selected for each project which will establish criteria for several design elements including horizontal and vertical curvature, superelevation, and sight distance. Section 31-2.02 discusses the selection of design speed.

2. Low Speed. For geometric design purposes, low speed is defined as 45 mph (70 km/h) or less.

3. High Speed. For geometric design purposes, high speed is defined as 50 mph (80 km/h) or greater.

4. Average Running Speed. Running speed is the average speed of a vehicle over a specified section of highway. It is equal to the distance traveled divided by the running time (the time the vehicle is in motion). The average running speed is the distance summation for all vehicles divided by the running time summation for all vehicles.

5. Average Travel Speed. Average travel speed is the distance summation for all vehicles divided by the total time summation for all vehicles. Note: Average running speed only includes the time the vehicle is in motion. Therefore, on uninterrupted flow facilities where travel is not congested, average running speed, and average travel speed are equal.

6. Operating Speed. Operating speed is the speed at which drivers are observed operating their vehicles during free-flow conditions. In practice, the term “operating speed” is commonly used to characterize prevailing vehicular speeds on a highway segment, either through field measurements of speed or through informal field observations. Although no precise percentile is used to define operating speed, it may be assumed to be between the 80th and 90th percentile of actual travel speeds.

7. 85th-Percentile Speed. The 85th-percentile speed is the speed below which 85 percent of vehicles travel on a given highway. The most common application of the value is its use as one of the factors for determining the posted, legal speed limit of a highway section. In most cases, field measurements for the 85th-percentile speed will be conducted during off-peak hours when drivers are free to select their desired speed.

8. Posted Speed Limit. The posted speed limit on State highways is typically based on traffic and engineering investigations, where statutory requirements do not apply. The district Bureau of Operations conducts traffic speed studies on the State highway system. The selection of a posted speed limit is based on several factors:

- the design speed used during project development;
- median type on multilane facilities;
- the 85th-percentile speed and pace speed;*
- highway functional classification and type of area;
- road surface characteristics, grade, alignment, and sight distance;
- type and density of roadside development;
- use of curb and gutter;
- the crash experience during the previous 12 months;
- the need for traffic signal progression; and
- parking practices and pedestrian and bicycle activity.

**Note: Pace speed is the specified increment of spot speed that includes the greatest number of speed measurements.*

9. Legal Speed Limit. Legal speed limits are those set by the Federal government or by the Illinois Statutes that will apply, for example, to those public roads that do not have a posted speed limit.

31-2.02 Design Speed Selection

A design speed is selected for each project, which will establish criteria for several geometric design elements including horizontal and vertical curvature, superelevation, cross sectional features, and sight distance. Part V, Highway Systems, presents the design speed criteria for new construction and reconstruction projects, 3R non-freeway projects, and 3R freeway projects. In general, the selected design speed is based on the following road design elements:

1. Functional Classification. The higher class facilities (i.e., arterials) are designed with a higher design speed than the lower class facilities (i.e., collectors and locals).

2. Urban/Rural. Design speeds in rural areas are generally higher than those in urban areas. This is consistent with the typically fewer constraints in rural areas (e.g., less development).

3. Terrain. The flatter the terrain, the higher the selected design speed can be. This is consistent with the typically higher construction costs associated with more rugged terrain.

4. Traffic Volumes. On some facilities (e.g., unmarked rural collectors), the design speed varies by traffic volumes; i.e., as traffic volumes increase, higher design speeds are used.

For geometric design application, the relationship between these road design elements and the selected design speed reflects general cost-effective considerations. For example, the higher the traffic volumes, the more benefits to the traveling public from a higher design speed.

In addition to the above, the selected design speed should equal or exceed the anticipated posted/regulatory speed limit of the facility after construction. This applies to all projects. The posted speed limit will be determined based on actual operating speeds of the completed facility and on several factors not directly related to the project design speed. Therefore, to avoid a potential conflict, the designer should coordinate the design speed selection with the district Bureau of Operations early in project development to assist in predicting the posted speed limit of the completed facility. If the proposed design speed will be less than the predicted posted speed limit, the designer must choose one of the following approaches:

- increase the project design speed to equal the anticipated posted speed limit,
- post the project with a legal speed limit equal to the design speed, or
- seek a design exception.

In selecting a design speed, the designer should avoid artificially selecting a design speed low enough to eliminate any design exceptions. For example, if the IDOT criteria yields a design speed of 60 mph (100 km/h) and one or more geometric features are adequate only for 55 mph (90 km/h), the project design speed should be 60 mph (100 km/h) and <u>not</u> 55 mph (90 km/h). The designer will then be required to seek design exceptions for the 55 mph (90 km/h) geometric features.

31-3 SIGHT DISTANCE

31-3.01 Stopping Sight Distance

31-3.01(a) Theoretical Discussion (Passenger Cars)

Stopping sight distance (SSD) is the sum of the distance traveled during a driver's perception/reaction (or brake reaction) time and the distance traveled while decelerating to a stop. To calculate SSD, the following formulas are used:

$$SSD = 1.47\ Vt + 1.075\ \frac{V^2}{a}$$ (US Customary) Equation 31-3.1

$$SSD = \frac{Vt}{3.6} + 0.039\ \frac{V^2}{a}$$ (Metric) Equation 31-3.1

where:
- SSD = stopping sight distance, ft (m)
- V = design speed, mph (km/h)
- t = brake reaction time, 2.5 seconds
- a = driver deceleration, ft/s^2 (m/s^2)

For calculating adjusted SSD for downgrades, see Equation 31-3.2.

The following briefly discusses the theoretical rationale for each assumption within the SSD model for passenger cars:

1. Brake Reaction Time. This is the time interval between when the obstacle in the road can first be physically seen and when the driver first applies the brakes. Based on several studies of observed driver reactions, the assumed value is 2.5 seconds. This time is considered adequate for approximately 90% of drivers in simple to moderately complex highway environments.

2. Braking Action. The braking action is based on the driver's ability to decelerate the vehicle while staying within the travel lane and maintaining steering control during the braking maneuver. A deceleration rate of 11.2 ft/s^2 (3.4 m/s^2) is considered comfortable for 90% of drivers for passenger cars.

3. Speed. The highway design speed is used to determine the initial driver speed.

AASHTO's *A Policy on Geometric Design of Highways and Streets* presents additional information on the assumptions used to develop the SSD model.

31-3.01(b) Passenger Cars (Level Grade)

Figure 31-3.A provides stopping sight distances for passenger cars on grades less than 3%. When applying the SSD values for passenger cars, the height of eye is assumed to be 3.5 ft (1080 mm) and the height of object 2 ft (600 mm). Except as noted in the following subsections, the SSD values in Figure 31-3.A apply to all projects.

US Customary					Metric				
Design Speed (mph)	Brake[1] Reaction Distance (ft)	Braking[2] Distance On Level (ft)	Stopping Sight Distance		Design Speed (km/h)	Brake[1] Reaction Distance (m)	Braking[2] Distance On Level (m)	Stopping Sight Distance	
			Calculated (ft)	Design (ft)				Calculated (m)	Design (m)
30	110.3	86.4	196.7	200	50	34.8	28.7	63.5	65
35	128.6	117.6	246.2	250	60	41.7	41.3	83.0	85
40	147.0	153.6	300.6	305	70	48.7	56.2	104.9	105
45	165.4	194.4	359.8	360	80	55.6	73.4	129.0	130
50	183.8	240.0	423.8	425	90	62.6	92.9	155.5	160
55	202.1	290.3	492.4	495	100	69.5	114.7	184.2	185
60	220.5	345.5	566.0	570	110	76.5	138.8	215.3	220
65	238.9	405.5	644.4	645	120	83.4	165.2	248.6	250
70	257.3	470.3	727.6	730					
75	275.6	539.9	908.3	910					

Notes:

1. *Brake reaction distance based on a time of 2.5 s.*
2. *Driver deceleration based on a rate of 11.2 ft/s^2 (3.4 m/s^2).*

STOPPING SIGHT DISTANCE
(Passenger Cars – Level Grade)

Figure 31-3.A

31-3.01(c) Trucks

The passenger SSD in Figure 31-3.A are not designed for truck operations. In general, trucks require longer SSD for a given speed than passenger vehicles. However, truck's higher height of eye (7.6 ft (2330 mm)) and driver experience tends to balance the need for additional stopping lengths for trucks than those for passenger cars (e.g., the truck driver can generally see further beyond a crest vertical curve). Consequently, separate truck SSD are generally not used in highway design. However, the designer should still consider providing longer SSD at the following sites:

- weigh stations;
- rest areas;
- in the vicinity of truck terminals;
- industrial parks;

- coal mining and quarry areas;
- where horizontal sight restrictions occur on downgrades;
- highway/railroad grade crossings on high-volume truck routes (e.g., truck DDHV of 250 or greater);
- other facilities with high truck traffic (e.g., routes with truck DDHV of 250 or greater); and
- locations that have a high incidence of truck crashes.

31-3.01(d) Downgrade-Adjusted SSD

The longitudinal gradient of the roadway impacts the distance needed for vehicles to brake to a stop. IDOT practice is to only consider the grade adjustment for downgrades, which increases braking distances. Equation 31-3.1 is modified as follows to calculate the adjusted SSD for downgrades:

$$SSD = 1.47Vt + \frac{V^2}{30\left[\frac{a}{32.2} \pm G\right]}$$ (US Customary) Equation 31-3.2

$$SSD = \frac{Vt}{3.6} + \frac{V^2}{254\left[\frac{a}{9.81} \pm G\right]}$$ (Metric) Equation 31-3.2

where:
- SSD = stopping sight distance, ft (m)
- V = design speed, mph (km/h)
- t = brake reaction time, typically 2.5 seconds
- a = driver deceleration, typically 11.2 ft/s^2 (3.4 m/s^2)
- G = grade expressed as a decimal. Downgrades are expressed as a negative.

Figure 31-3.B presents the downgrade SSDs for passenger cars. The designer should make a reasonable effort to meet these SSD values when downgrades are 3% or steeper. However, the grade-adjusted SSD values do not require a design exception when not met.

31-3.02 Decision Sight Distance

31-3.02(a) Theoretical Discussion

At some sites, drivers may be required to make decisions where the highway environment is difficult to perceive or where unexpected maneuvers are required. These are areas of concentrated demand where the roadway elements, traffic volumes, and traffic control devices

US Customary								
SSD for Downgrades (ft)								
Design Speed (mph)	(3%)	(4%)	(5%)	(6%)	(7%)	(8%)	(9%)	(10%)
30	205	210	215	215	220	225	230	235
35	260	265	270	275	280	285	290	295
40	315	325	330	335	340	350	355	365
45	380	385	395	400	410	420	430	440
50	450	455	465	475	485	495	510	525
55	520	530	545	555	570	580	595	610
60	600	615	625	640	655	670	690	705
65	685	700	715	730	750	765	790	810
70	775	790	810	825	850	870	895	920
75	870	885	906	930	955	980	1005	1035
Metric								
SSD for Downgrades (m)								
Design Speed (km/h)	(3%)	(4%)	(5%)	(6%)	(7%)	(8%)	(9%)	(10%)
50	66	67	68	70	71	72	74	75
60	87	88	90	92	93	95	97	100
70	110	112	114	116	119	122	124	127
80	136	138	141	144	147	151	154	158
90	164	167	171	174	178	183	187	192
100	194	198	203	207	212	218	223	230
110	227	232	238	243	249	256	263	270
120	263	268	275	281	288	296	304	313

1. *Calculated SDDs are not shown. Values in table have been determined by using Equation 31-3.2 and rounding up to the next highest 5 ft (1 m) increment.*

2. *For grades less than 3%, no adjustment is necessary; i.e., use the level SSD values (Figure 31-3.A).*

3. *For grades intermediate between table values, use a straight-line interpolation to determine the SSD or use Equation 31-3.2 and round up to the next highest 5 ft (1 m) increment.*

STOPPING SIGHT DISTANCE
(Passenger Cars — Adjusted for Downgrades)

Figure 31-3.B

may all compete for the driver's attention. This relatively complex environment may increase the required driver perception/reaction time beyond that provided by the SSD values (2.5 seconds) and, in some locations, the desired vehicular maneuver may be a speed/path/direction change rather than a stop. At these locations, the designer should consider providing decision sight distance to provide an additional margin of safety. The various avoidance maneuvers assumed in the development of Figure 31-3.C are:

1. Avoidance Maneuver A. Stop on rural road.
2. Avoidance Maneuver B. Stop on urban road.
3. Avoidance Maneuver C. Speed/path/direction change on rural road.
4. Avoidance Maneuver D. Speed/path/direction change on suburban road.
5. Avoidance Maneuver E. Speed/path/direction change on urban road.

31-3.02(b) Applications

In general, the designer should consider using decision sight distance at any relatively complex location where the driver perception/reaction time may exceed 2.5 seconds. Example locations where decision sight distance may be appropriate include:

- freeway exit/entrance gores;
- freeway lane drops;
- freeway left-side entrances or exits;
- intersections near a horizontal curve;
- highway/railroad grade crossings;
- approaches to detours and lane closures;
- along high-speed, high-volume urban arterials with considerable roadside friction; or
- isolated traffic signals on high-speed rural highways.

As with SSD, the driver height of eye is 3.5 ft (1080 mm) and the height of object is typically 2 ft (600 mm). However, candidate sites for decision sight distance may also be candidate sites for assuming that the "object" is the pavement surface (e.g., freeway exit gores). Therefore, the designer may assume a 0.0 in (0.0 mm) height of object for application at some sites.

31-3.03 Passing Sight Distance

Passing sight distance only applies to two-lane, two-way highways. Therefore, its theoretical derivation and application are discussed in Chapter 47.

31-3.04 Intersection Sight Distance

Intersection sight distance applies to the determination of the sight triangle in the corners of at-grade intersections. Therefore, its theoretical derivation and application are discussed in Chapter 36.

US Customary					
Design Speed (mph)	Decision Sight Distance for Avoidance Maneuver (ft)				
	A	B	C	D	E
30	220	490	450	535	620
35	275	590	525	625	720
40	330	690	600	715	825
45	395	800	675	800	930
50	465	910	750	890	1030
55	535	1030	865	980	1135
60	610	1150	990	1125	1280
65	695	1275	1050	1220	1365
70	780	1410	1105	1275	1445
75	875	1545	1180	1365	1545
Metric					
Design Speed (km/h)	Decision Sight Distance for Avoidance Maneuver (m)				
	A	B	C	D	E
50	70	155	145	170	195
60	95	195	170	205	235
70	115	235	200	235	275
80	140	280	230	270	315
90	170	325	270	315	360
100	200	370	315	355	400
110	235	420	330	380	430
120	265	470	360	415	470

Note:

Avoidance Maneuver A: Stop on rural road.
Avoidance Maneuver B: Stop on urban road.
Avoidance Maneuver C: Speed/path/direction change on rural road.
Avoidance Maneuver D: Speed/path/direction change on suburban road.
Avoidance Maneuver E: Speed/path/direction change on urban road.

DECISION SIGHT DISTANCE

Figure 31-3.C

31-4 CAPACITY METHODOLOGY

31-4.01 Definitions

1. Actuated Control. A defined phase sequence in which the presentation of each phase is on recall or the associated traffic movement has submitted a call for service through a detector.

2. Annual Average Daily Traffic (AADT). The total yearly volume in both directions of travel divided by the number of days in a year.

3. Average Daily Traffic (ADT). The calculation of average traffic volumes in both directions of travel in a time period greater than one day and less than one year and divided by the number of days in that time period. Although not precisely correct, ADT is often used interchangeably with AADT. The use of an ADT could produce a bias because of seasonal peaks and, therefore, the user should be aware of this.

4. Back of Queue. The maximum backward extent of queued vehicles during a typical cycle, as measured from the stop line to the last queued vehicle.

5. Capacity. The maximum number of vehicles that can reasonably be expected to traverse a point or uniform section of a lane or roadway during a given time period under prevailing roadway, traffic, and traffic control conditions. The time period most often used for analysis is 15 minutes. “Capacity” corresponds to Level of Service E.

6. Cycle. A complete sequence of signal indications.

7. D-Factor. The portion of traffic moving in the peak direction of travel on a given roadway during the peak hour.

8. Delay. Additional travel time experienced by a driver, passenger, bicyclist, or pedestrian beyond that required to travel at the desired speed. The primary performance measure on interrupted flow facilities

9. Demand Flow Rate. The count of vehicles arriving at the system element during the analysis period, converted to an hourly rate. This manual uses the term design hourly volume (defined below) in a similar manner as demand flow rate.

10. Density. The number of vehicles occupying a given length of lane, averaged over time. It is usually expressed as vehicles per mile (kilometer) per lane.

11. Design Hourly Volume (DHV). The one-hour volume in both directions of travel in the design year selected for determining the dimensions and configuration of the highway design elements. For capacity analyses, the DHV is typically converted to an hourly flow rate based on the maximum 15-minute flow rate during the DHV. The term DHV is not used in the *Highway Capacity Manual*, but its utility is similar to how demand flow rate (defined above) is used.

12. Directional Design Hourly Volume (DDHV). The traffic volume in the peak direction of flow during the design hour.

13. Directional Distribution (D). A characteristic of traffic that volume may be greater in one direction than in the other during any particular hour on a highway.

14. 85^{th} Percentile Speed. A speed value that is exceeded by 15% of the vehicles in a traffic stream.

15. Flow Rate. The equivalent hourly rate at which vehicles or other roadway users pass over a given point or section of a lane or roadway during a given time interval of less than one hour, usually 15 minutes.

16. Free Flow. A flow of traffic unaffected by upstream or downstream conditions.

17. Green Time (g/c) Ratio. The ratio of the effective green time of a phase to the cycle length.

18. Heavy Vehicles. A vehicle with more than four wheels touching the pavement during normal operation.

19. K-Factor. The portion of AADT that occurs during the peak hour. (DHV/AADT)

20. Lane Group. A lane or set of lanes designated for separate analysis.

21. Level of Service (LOS). A quantitative stratification of a performance measure or measures that represent quality of service, measured on an A to F scale, with LOS A representing the best operating conditions from the traveler’s perspective and LOS F the worse.

22. Passenger–Car Equivalent. The number of passenger cars that will result in the same operational conditions as a single heavy vehicle of a particular type under specified roadway, traffic, and control conditions.

23. Peak Hour. The hour of the day in which the maximum volume occurs.

24. Peak-Hour Factor (PHF). A ratio of the volume occurring during the peak hour to the maximum rate of flow during a given time period within the peak hour (typically 15 minutes).

25. Pedestrian. An individual traveling on foot.

26. Permitted Turn. A left or right turn at a signalized intersection that is made by a vehicle during a time in the cycle in which the vehicle does not have the right-of-way.

27. Phase. The part of the signal cycle allocated to any combination of traffic movements receiving the right-of-way simultaneously during one or more intervals. A phase includes the green, yellow, and red clearance intervals.

28. Progression. The act of various controllers providing specific green indications in accordance with a time schedule to permit continuous operation of groups of vehicles along the street at a planned speed.

29. Protected Turn. The left or right turns at a signalized intersection that are made by a vehicle during a time in the cycle when the vehicle has the right-of-way.

30. Queue Storage Ratio. The maximum back of queue as a proportion of the available storage on the subject lane or link.

31. Red Clearance Interval. A brief period of time following the yellow indication during which the signal heads associated with the ending phase and all conflicting phases display a red indication.

32. Saturation Flow Rate. The equivalent hourly rate at which previously queued vehicles can traverse an intersection approach under prevailing conditions, assuming that the green signal is available at all times and no lost times are experienced.

33. Semi-Actuated Control. A signal control in which some approaches (typically on the minor street) have detectors and some approaches (typically on the major street) have no detectors.

34. Service Flow Rate. The maximum directional rate of flow that can be sustained in a given segment under prevailing roadway, traffic, and control conditions without violating the criteria for level of service *i*.

35. Service Measure. A performance measure used to define LOS for a transportation system element.

36. Volume-to-Capacity (v/c) Ratio. The ratio of flow rate to capacity for a system element.

37. Weaving. The crossing of two or more traffic streams traveling in the same direction along a significant length of highway, without the aid of traffic control devices (except for guide signs).

31-4.02 Design Year Selection

31-4.02(a) Roadway Design

The geometric design of a highway should be developed to accommodate expected traffic volumes during the life of the facility assuming reasonable maintenance. This involves projecting the traffic volumes to a selected future year. Recommended design years are presented in Figure 31-4.A. The design year is measured from the expected construction completion date. Projected traffic volumes on State highways are provided by each district or from regional transportation studies with support from the OPP, Planning Services Section.

Project Scope Of Work	Typical
New Construction/Reconstruction	20 Years
3R Freeway Projects	Current*
3R Non-Freeway Projects	Current*

* *In general, current traffic volumes may be used. However, if a 3R project will introduce a new geometric design element (e.g., relocation of a horizontal curve), the element should be designed based on reconstruction policies.*

RECOMMENDED DESIGN YEAR SELECTION
(Traffic Volumes for Road Design)

Figure 31-4.A

31-4.02(b) Other Highway Elements

The following presents the recommended criteria for selection of a design year for highway elements other than road design:

1. Bridges. The structural life of a bridge may be 75 years or more. For new bridges, bridge replacement, and bridge reconstruction, the clear roadway width of the bridge will be based on the 20-year traffic volume projection beyond the construction completion date. In addition, the designer may, on selected projects, evaluate if the bridge design will reasonably accommodate structural expansion to meet the clear roadway width across the bridge based on a traffic volume projection beyond 20 years.

   For bridges within the limits of 3R projects, see Chapters 49 and 50.

2. Underpasses. The design year used for the geometric design of underpasses will be determined on a case-by-case basis.

3. Right-of-Way/Grading. The designer may consider potential right-of-way needs for the anticipated long-term corridor growth for a year considerably beyond that used for roadway design, especially in large metropolitan areas. No specific design year is recommended for use. For example, when selecting an initial median width on a divided highway, the designer may evaluate the potential need for future expansion of the facility to add through travel lanes. Other examples include potential future interchanges, potential reconstruction of a two-lane, two-way facility to a multilane highway, and the use of flatter side slopes to provide more future options.

4. Drainage Design. Drainage appurtenances are designed to accommodate a flow rate based on a specific design year (or frequency of occurrence). The selected design year or frequency will be based on the functional class of the facility, the ADT, and the

specific drainage appurtenance (e.g., culvert). The IDOT *Drainage Manual* presents the Department's criteria for selecting the frequency of occurrence. The design life of new drainage structures is typically 50 years.

5. Pavement Design. The pavement structure is designed to withstand the vehicular loads during the design analysis period without falling below a selected pavement serviceability rating. Chapter 54 presents the Department's criteria for selecting a design year for pavements.

6. Environmental Analyses. Some environmental analyses require the selection of a future year for design (e.g., noise analyses). BDE determines the specific criteria for environmental analyses.

31-4.03 Design Hourly Volume Selection

For most geometric design elements that are determined by traffic volumes, the peaking characteristics are most significant. The highway facility should be able to accommodate the design hourly volume (adjusted for the peak-hour factor) at the selected level of service. This design hourly volume (DHV) will affect many design elements including the number of through travel lanes, lane and shoulder widths, and intersection geometrics. The designer should also analyze the proposed design using the a.m. and p.m. DHV's separately. This could have an impact on the geometric design of the highway. The *Highway Capacity Manual* uses the term demand flow rate similarly as design hourly volume.

Traditionally, the 30th highest hourly volume in the selected design year has been used to determine the DHV for design purposes. This is still considered appropriate for rural facilities. However, at the discretion of the district, for urban facilities it may be more appropriate to base the DHV on the 10th to 20th highest hourly volume in the selected design year. Because the design of the project is significantly dependent upon the projected design hourly volumes, these projections must be carefully examined before using for design purposes.

31-4.04 Level of Service

Level of service (LOS) describes a quantitative stratification of a performance measure or measures that represent quality of service, measured on an A to F scale. A designated LOS is described in terms of service measures such as speed, density, delay, or percent time-spent-following.

Because drivers will accept different driving operational conditions, including lower travel speeds on different facilities, it is not practical to establish one level of service for application to every type of highway. Therefore, various levels of service have been established for the different types of highways facilities, location (i.e., rural or urban) and the scope of the improvement.

Part V, Highway Systems, presents LOS criteria for each highway type.

31-4.05 Capacity Analyses

31-4.05(a) Objective

The highway mainline, intersection, or interchange should be designed to accommodate the design hourly volume (DHV) at the selected level of service (LOS). The methodologies in the *Highway Capacity Manual* (HCM) uses the DHV, or demand flow rate, and the various highway factors which affect capacity to determine the LOS.

The maximum directional rate of flow that can be sustained in a given segment for a selected LOS, the definition for service flow rate, should be accommodated by adjusting the various highway factors which affect capacity until a suitable design is determined. The service flow rate of the facility is calculated by applying adjustments such as heavy vehicles and driver population to a base flow rate. By definition, the service flow rate for LOS E is synonymous with capacity for all uninterrupted-flow facilities and their components.

The HCM has established service measures to determine the level-of-service for various highway elements on different types of highway facilities. These are presented in Figure 31-4.B. For each service measure, the HCM will provide the analytical tools to calculate the numerical value. The designer should note that highway capacity service measures are segregated into two broad categories: (1) uninterrupted flow, or open highway conditions, which occurs on facilities that have no fixed causes of delay or interruption external to the traffic stream such as the influence of an intersection, and (2) interrupted flow which occur on facilities characterized by traffic signals, STOP signs, YIELD signs or other fixed causes of periodic delay or interruption to the traffic stream

The following presents the simplified procedure for conducting a capacity analysis for the highway mainline:

1. Select the design year (Section 31-4.02).

2. Determine the DHV (Section 31-4.03).

3. Select the design level of service (see Part V, Highway Systems).

4. Document the proposed highway geometric design (lane width, length of weaving section, number and width of approach lanes at intersections, etc.).

5. Using the HCM, analyze the capacity of the highway element for the proposed design:

   - determine the maximum flow rate under ideal conditions;

   - adjust the maximum flow rate for prevailing roadway, traffic, and traffic control conditions; and

   - calculate the service flow rate for the selected level of service.

6. Compare the calculated service flow rate to the DHV. If the DHV is less than or equal to the service flow rate, the proposed design will meet the objectives of the capacity analysis. If the DHV exceeds the service flow rate, the proposed design may need further evaluation. The designer should either adjust the highway design or should adjust one of the capacity elements (e.g., the selected design year or the level-of-service goal).

Type of Facility	Service Measures
Vehicular	
Interrupted Flow	
Urban street segment	travel speed/Base FFS
Signalized intersection	delay
Two-way stop intersection	delay
All-way stop intersection	delay
Interchange ramp terminal	delay
Roundabout	delay
Uninterrupted Flow	
Two-lane highway	average travel speed, percent time-spent-following percent of free-flow speed
Multilane highway	density
Freeway	
Basic segment	density
Ramp merge segment	density
Ramp diverge segment	density
Weaving segment	density
Other Road Users	
Pedestrian	space, delay, LOS score
Bicycle	LOS score

SERVICE MEASURES FOR LEVEL OF SERVICE

Figure 31-4.B

31-4.05(b) Responsibility

For IDOT projects, the district Geometrics Engineer (or sometimes the project engineer) is responsible for performing all capacity analyses required by the project. The Policy and Procedures Section or the Project Development and Implementation Section is available as a resource to the district to assist in all capacity analyses. For consultant-designed projects, the consultant is responsible for performing capacity analyses. Consultants must use only highway capacity software that is approved by BDE.

31-4.06 Service Flow Rate

For general design purposes, IDOT uses a volume threshold designated as the service flow rate (SF) for the various highway classes. Service flow rate is taken from the *Highway Capacity Manual* (HCM) and is defined as the maximum volume that can be accommodated at a selected level of service (LOS) based on a typical set of operational assumptions for each facility.

As discussed in the HCM the base capacity of a facility at any LOS varies with the free-flow speed. For example, the base capacity for a basic freeway segment for LOS E ranges from 2250 at 55 mph (90 km/h) to 2400 at 75 mph (120 km/h) passenger cars per hour per lane under base conditions. The maximum service flow rate at LOS E, or MSF_E, is, also considered the capacity of a freeway, expressway, or arterial multilane highway. Base conditions include 12 foot lanes, a minimum of 6 foot right-side clearance, no heavy vehicles, no ramps, and a driver population composed primarily of regular users who are familiar with the facility.

The geometric design criteria tables in Part V, Highway Systems, present the service flow rate volumes for the applicable highway types at the design LOS. Factors which determine SF are the same as the base conditions above exclusive of lane width, lateral clearance and ramp density. Variances from the remaining base conditions causing operational constraints will cause a decrease to the SF. As discussed in the HCM these adjustments include the number of lanes (N), percent of heavy vehicles (f_{HV}), and driver population (f_P). To determine the SF_i at LOS i, use the MSF_i at the desired LOS i (e.g. see Exhibit 11-17 of the HCM). The equation for determining the SF_i for LOS i is:

$$SF_i = (MSF_i)\,(N)\,(f_{HV})\,(f_P). \qquad \text{Equation 31-4.1}$$

This equation is applicable for basic freeway segments (Chapter 44), expressways (Chapter 45), and arterial multilane highways (Chapter 47).

The SF’s shown in the tables in Part V for multilane highways are one-way volumes derived from the above equation using appropriate HCM values and assume the following truck percentages for f_{HV}: freeways – 16%, expressways and arterial multilane highways– 8%. A PHF = 1.0 has been assumed, and the SF’s found in the Part V tables for multilane highways must be multiplied by the actual PHF.

Capacity for a two lane rural highway (Chapter 47), which also exists at the boundary between LOS E and LOS F, is not determined by a measure of effectiveness. Under base conditions (12 foot or wider lanes, 6 foot or wider shoulders, no no-passing zones, all passenger cars, level terrain, and no impediments to through traffic) the capacity of a two-lane rural highway (in one direction) is 1700 passenger cars per hour (pcph). The capacity of two-lane rural highway under base conditions is 3200 pcph total in both directions.

The equation for determining the SF_i for LOS *i* for two-lane rural highways is:

$SF_i = (2800)\,(v/c)_i\,(f_d)\,(f_w)\,(f_{HV})$ where; Equation 31-4.2

v/c = the ratio of flow rate to an ideal capacity of 2800 pcph in both directions;
f_d = the adjustment factor for the directional distribution of traffic (assumed as 60%/40%);
f_w = the adjustment factor for narrow lanes and shoulders and;
f_{HV} = the adjustment factor for the presence of heavy vehicles.

This equation and method to determine SF are from Chapter 8 of the 1994 HCM. Service flow rates in the 2011 HCM are ancillary to the performance measures for two-lane rural highways, therefore the method to determine SF for two-lane rural highways is complicated requiring an iterative process giving questionable results. The method to determine SF using the 1994 HCM is accurate enough for planning purposes. The volumes shown in Part V for rural two-lane highways assume 100% passing sight distance, a 60%/40% directional distribution, 6% heavy vehicle percentage, and a PHF = 1. On a project length basis, as much passing sight distance as practical should be provided with approximately 60% available as a minimum for level terrain and approximately 40% as a minimum for rolling terrain.

31-5 NON-HIGHWAY DESIGN CONTROLS

The characteristics of drivers and vehicles significantly influence the selected design criteria. When the driver and vehicle are properly accommodated, the safety and serviceability of the highway system are enhanced. When they are not accommodated, crashes and inefficient operation may result.

31-5.01 Driver

31-5.01(a) Typical Driver

The appropriate considerations for drivers are already built into the applicable geometric design values (stopping sight distance, horizontal curvature, superelevation, roadway widths, etc.). However, a brief discussion of the "typical" driver is warranted.

Drivers vary widely in their operating skills, experience, intelligence, and physical condition. The highway should be as forgiving as practical to minimize the adverse effects of driver errors. The following describes certain principles and driver traits that should be incorporated into the roadway design:

1. Information Processing. Drivers are limited in how quickly they can gather information, make a decision, and take action. They must process information related to lane placement, speed, traffic control devices, highway alignment, roadside conflicts, and weather. If the amount, complexity, or clarity of the information is inappropriate or excessive, driver error leading to a crash can result.

2. Primacy. Certain driving functions are more important than others. In order of importance they are:

   - Control — activities related to the physical control of the vehicle via the steering wheel, brake, or accelerator.
   - Guidance — activities related to selecting a safe speed and vehicular path on the highway.
   - Navigation — activities related to planning and executing a trip from point of origin to destination.

   The roadway designer must be aware of the relative importance of these activities and ensure that the more important highway information is properly conveyed to the driver. This could result in the decision to remove or relocate lower priority information, if it is likely to interfere with the higher priority information.

3. Expectancy. Drivers are conditioned through experience and training to expect and anticipate what lies ahead on the highway. If this driver expectancy is violated, it will increase the time needed by the driver to assess the situation and make the correct

decision. These violations should be avoided. Where they are unavoidable, the designer should allow for increased warning time.

4. Speed. Speed must be considered when accommodating the driver. Higher speeds reduce the visual field and restrict peripheral vision.

A User's Guide to Positive Guidance (FHWA) contains more detailed information related to driver characteristics and highway design accommodation for the driver.

31-5.01(b) Elderly Driver

In general, the median age of drivers in the United States is increasing and, specifically, the age bracket of over 60 years is the fastest growing segment of the driver population. This reality greatly emphasizes the criticality of the relationship between the driver and the highway environment. Although the opinions are not unanimous, there is general agreement that advancing age has a deleterious effect on an individual's perceptual, mental, and motor skills — critical factors in vehicular operation.

The research community has conducted several studies of the elderly driver, including:

- "Older Driver Study of Traffic Control Devices in Illinois," Illinois Department of Transportation, 1991;
- "Highway Design and Traffic Operation Needs of Older Drivers," University of Illinois at Urbana - Champaign, January 1994;
- "Strategies for Improving the Safety of Elderly Drivers," University of Nebraska/Midwest Transportation Center, 1991; and
- "Highway Design Handbook for Older Drivers and Pedestrians," FHWA, 2001.

These four studies were primarily focused on the relationship between the elderly driver and traffic control devices where, arguably, a greater opportunity exists for cost-effective countermeasures than for roadway design. However, it is important for the road designer to be aware of the needs of the elderly driver and, where desirable, factor these needs into the roadway design. The following summarizes the more important observations from these studies:

1. Elderly Driving Characteristics. When compared to younger drivers, the elderly driver often exhibits the following operational deficiencies:

   - slower information processing;
   - slower reaction times;
   - slower decision making;
   - visual deterioration;
   - hearing deterioration;
   - decline in ability to judge time, speed, and depth perception;

- limitations on physical mobility; and
- side effects from prescription drugs.

2. Crash Frequency. Predictably, elderly drivers are involved in a disproportionate number of crashes where there is a higher than average demand imposed on driving skills. The driving maneuvers that most often precipitate higher crash frequencies among older drivers include:

   - left turns across traffic,
   - merging with high-speed traffic,
   - changing lanes on congested streets,
   - crossing high-volume intersections,
   - need to stop quickly for queued traffic,
   - backing maneuvers, and
   - parking.

3. Countermeasures. The studies identified several countermeasures to alleviate the potential problems of the elderly driver. These included:

   - increasing driver education;
   - increasing vehicular clearance times at signalized intersections;
   - increasing pedestrian phase times;
   - providing wider and brighter pavement markings;
   - providing larger and brighter signs;
   - reducing sign clutter;
   - providing more redundant information (e.g., advance guide signs);
   - installing grade separations;
   - revising warrants for traffic signals to increase their usage;
   - enforcing speed limits;
   - widening intersections;
   - increasing use of protected left-turn phases; and
   - increasing sight distance.

   Most of the proposed countermeasures are related to traffic control devices. Perhaps the most practical measure related to road design is increasing sight distance. From an implementation perspective, this recommendation may be related to the warrants for the use of decision sight distance, as discussed in Section 31-3. The gradual aging of the driver population suggests that an increased use of decision sight distance may produce a commensurate reduction in the crash frequency for elderly drivers. These findings suggest that, where decision sight distance cannot physically be provided, an increased use of advance warning signs may be appropriate.

31-5.02 Vehicle

The physical and operational characteristics of vehicles using the highway are important controls in roadway design. Design criteria may vary according to the type of vehicle and the volume of each type of vehicle in the traffic stream.

Vehicular characteristics that impact design include:

1. Size. Vehicular sizes determine lane and shoulder widths, vertical clearances and, indirectly, highway capacity calculations.

2. Offtracking. The design of intersection turning radii, traveled way widening for horizontal curves, and pavement widths for interchange ramps are usually controlled by the largest design vehicle likely to use the facility with some frequency.

3. Storage Requirements. Turn bay storage lengths, bus turnouts, and parking lot layouts are determined by the number and types of vehicles to be accommodated.

4. Sight Distance. Eye height and braking distances vary for passenger cars and trucks, which can impact sight distance considerations.

5. Acceleration and Deceleration. Acceleration and deceleration rates often govern the dimensioning of such design features as speed-change lanes at intersections and interchange ramps and climbing lanes.

6. Vehicular Stability. Certain vehicles with high centers of gravity may be prone to skidding or overturning, affecting design speed selection and superelevation design elements.

Figures 31-5.A and 31-5.B present vehicular dimensions and minimum turning radii for typical design vehicles. Figures 31-5.C and 31-5.D present two combination trucks to illustrate the application of the basic dimensions.

The selection of appropriate design vehicles for intersections and interchanges are discussed in Chapters 36 and 37, respectively.

31-5.03 Pedestrians

The pedestrian must be considered as an integral part of the highway environment, especially in urban areas. Except on fully access-controlled facilities, pedestrians are legally allowed to use the highway right-of-way consistent with the restrictions placed on pedestrian use. Therefore, the roadway design should provide for the safe and efficient movement of pedestrians, within practical limits, without compromising the accommodation of the vehicles using the highway facility.

Design Vehicle Type	Symbol	Dimensions (feet)										
		Overall			Overhang		Wheelbases					Typical Kingpin to Center of Rear Axle
		Height	Width	Length	Front	Rear	WB_1	WB_2	S	T	WB_3	
Passenger car	P	4.25	7	19	3	5	11	–	–	–	–	–
Single unit truck	SU	11-13.5	8.0	30	4	6	20	–	–	–	–	–
City transit bus	CITY-BUS	10.5	8.5	40	7	8	25	–	–	–	–	–
Articulated bus	A-BUS	11.0	8.5	60	8.6	10	22.0	19.4	6.2[a]	13.2[a]	–	–
School bus (84 passenger)	S-BUS	10.5	8.0	40	7	13	20	–	–	–	–	–
Combination trucks:												
Intermediate Semitrailer	WB-40	13.5	8.0	45.5	3	2.5[a]	12.5	27.5	–	–	–	27.5
Large Semitrailer	WB-50	13.5	8.5	55	3	2[a]	14.6	35.4	–	–	–	37.5
Large Semitrailer*	WB-55	13.5	8.5	66	3.5	7.5	14.6	40.4	–	–	–	42.5
Semitrailer - Full Trailer ("Double Bottom")	WB-67D	13.5	8.5	73.3	2.33	3	11.0	23.0	3.0[b]	7.0[b]	23.0	23.0
Interstate Semitrailer*	WB-65	13.5	8.5	73.5	4	4.5-2.5[a]	21.6	43.4-45.4	-	–	–	45.5-47.5
Recreational vehicles:												
Motor home	MH	12	8	30	4	6	20	–	–	–	–	–
Car and camper trailer	P/T	10	8	48.7	3	10	11	–	5	19	–	–
Car and boat trailer	P/B	10	8	42	3	8	11	–	5	15	–	–
Motor home and boat trailer	MH/B	12	8	53	4	8	20	–	6	15	–	–

** On semitrailers longer than 48 ft, the maximum distance between the kingpin and the rear axle shall not exceed 45.5 ft.*

a = Combined dimension of 19.4 ft is typical.
b = Combined dimension of 10.0 ft is typical.

WB_1, WB_2, WB_3 are effective vehicle wheelbases, starting at the front and moving towards the back of the vehicle.
S is the distance from the rear effective axle of a vehicle to the hitch point or, for A-BUS, the distance from second axle to articulating section.
T is the distance from the hitch point of a vehicle to the lead effective axle or axle set of the following unit or, for A-BUS, the distance from articulating section to rear axle.

TYPICAL DESIGN VEHICLE DIMENSIONS
(US Customary)

Figure 31-5.A

Design Vehicle Type	Symbol	Dimensions (meters)										
		Overall			Overhang		Wheelbases					Typical Kingpin to Center of Rear Axle
		Height	Width	Length	Front	Rear	WB_1	WB_2	S	T	WB_3	
Passenger car	P	1.3	2.1	5.8	0.9	1.5	3.4	–	–	–	–	–
Single unit truck	SU	3.4-4.1	2.4	9.2	1.2	1.8	6.1	–	–	–	–	–
City transit bus	CITY-BUS	3.2	2.6	12.2	2.1	2.4	7.6	–	–	–	–	–
Articulated bus	A-BUS	3.4	2.6	18.3	2.6	3.1	6.7	5.9	1.9[a]	4.0[a]	–	–
School bus (84 passenger)	S-BUS	3.2	2.4	12.2	2.1	4.0	6.1	–	–	–	–	–
Combination trucks:												
Intermediate Semitrailer	WB-12	4.1	2.4	13.9	0.9	0.8[a]	3.8	8.4	–	–	–	8.4
Large Semitrailer	WB-15	4.1	2.6	16.8	0.9	0.6[a]	4.5	10.8	–	–	–	11.4
Large Semitrailer*	WB-17	4.1	2.6	20.19	1.13	2.29	4.45	12.32	–	–	–	13.0
Semitrailer - Full Trailer ("Double Bottom")	WB-20D	4.1	2.6	22.4	0.7	0.9	3.4	7.0	0.9[b]	2.1[b]	7.0	7.0
Interstate Semitrailer*	WB-20	4.1	2.6	22.4	1.2	1.4-0.8[a]	6.6	13.2-13.8	–	–	–	13.9–14.5
Recreational vehicles:												
Motor home	MH	3.7	2.4	9.2	1.2	1.8	6.1	–	–	–	–	–
Car and camper trailer	P/T	3.1	2.4	14.0	0.9	3.1	3.4	–	1.5	5.8	–	–
Car and boat trailer	P/B	3.1	2.4	12.8	0.9	2.4	3.4	–	1.5	4.6	–	–
Motor home and boat trailer	MH/B	3.7	2.4	16.2	1.2	2.4	6.1	–	1.8	4.6	–	–

** On semitrailers longer than 14.63 m, the maximum distance between the kingpin and the rear axle shall not exceed 13.87 m.*

a = Combined dimension of 5.91 m is typical.
b = Combined dimension of 3.25 m is typical.

WB_1, WB_2, WB_3 are effective vehicle wheelbases, starting at the front and moving towards the back of the vehicle.
S is the distance from the rear effective axle of a vehicle to the hitch point or, for A-BUS, the distance from second axle to articulating section.
T is the distance from the hitch point of a vehicle to the lead effective axle or axle set of the following unit or, for A-BUS, the distance from articulating section to rear axle.

TYPICAL DESIGN VEHICLE DIMENSIONS (Metric)

Figure 31-5.A

Design Vehicle Type	Passenger Car	Single-Unit Truck	Intercity Bus (Motor Coach)		City Transit Bus	Conventional School Bus (65 pass.)	Large[2] School Bus (84 pass)	Articulated Bus	Inter-mediate Semi-Trailer	Inter-mediate Semi-Trailer
Symbol	P	SU	BUS-40	BUS-45	CITY-BUS	S-BUS36	S-BUS40	A-BUS	WB-40	WB-50
Minimum Design Turning Radius (ft)	24	42	45	45	42.0	38.9	39.4	39.8	40	45
Centerline[1] Turning Radius (CTR) (ft)	21	38	40.8	40.8	37.8	34.9	35.4	35.5	36	41
Minimum Inside Radius (ft)	14.4	28.3	27.6	25.5	24.5	23.8	25.4	21.3	19.3	17.0

Design Vehicle Type	Large Semi-trailer	Semitrailer Interstate		"Double Bottom" Combination	Semi-trailer/ trailers	Turnpike Double Semi-trailer/ trailer	Motor Home	Car with Camper Trailer	Car with Boat Trailer	Motor Home and Boat Trailer	Farm[3] Tractor w/One Wagon
Symbol	WB-55	WB-62*	WB-65**or WB-67	WB67D	WB-100T	WB-109D*	MH	P/T	P/B	MH/B	TR/W
Minimum Design Turning Radius (ft)	45	45	45	45	45	60	40	33	24	50	18
Centerline [1] Turning Radius (CTR) (ft)	41	41	41	41	41	56	36	30	21	46	14
Minimum Inside Radius (ft)	18.4	17.9	4.4	19.3	9.9	14.9	25.9	17.4	8.0	35.1	10.5

* Design vehicle with 48-ft trailer as adopted in 1982 *Surface Transportation Assistance Act* (STAA).
** Design vehicle with 53-ft trailer as grandfathered in with 1982 *Surface Transportation Assistance Act* (STAA).

1 The turning radius assumed by a designer when investigating possible turning paths and is set at the centerline of the front axle of a vehicle. If the minimum turning path is assumed, the CTR approximately equals the minimum design-turning radius minus one-half the front width of the vehicle.

2 School buses are manufactured from 42-passenger to 84-passenger sizes. This corresponds to wheel base lengths of 11.0 ft to 20.0 ft, respectively. For these different sizes, the minimum design turning radii vary from 28.8 ft to 39.4 ft and the minimum inside radii vary from 14.0 ft to 25.4 ft.

3 Turning radius is for 150-200 hp tractor with one 18.5-ft long wagon attached to hitch point. Front wheel drive is disengaged and without brakes being applied.

MINIMUM TURNING RADII OF TYPICAL DESIGN VEHICLES
(US Customary)

Figure 31-5.B

Design Vehicle Type	Passenger Car	Single-Unit Truck	Intercity Bus (Motor Coach)		City Transit Bus	Conventional School Bus (65 pass.)	Large[2] School Bus (84 pass)	Articulated Bus	Inter-mediate Semi-Trailer	Inter-mediate Semi-Trailer
Symbol	P	SU	BUS-12	BUS-14	CITY-BUS	S-BUS11	S-BUS12	A-BUS	WB-12	WB-15
Minimum Design Turning Radius (m)	7.3	12.8	13.7	13.7	12.8	11.9	12.0	12.1	12.2	13.7
Centerline[1] Turning Radius (CTR) (m)	6.4	11.6	12.4	12.4	11.5	10.6	10.8	10.8	11.0	12.5
Minimum Inside Radius (m)	4.4	8.6	8.4	7.8	7.5	7.3	7.7	6.5	5.9	5.2

Design Vehicle Type	Large Semi-trailer	Interstate Semitrailer		"Double Bottom" Combination	Semi-trailer/ trailers	Semi-trailer/ trailer	Motor Home	Car with Camper Trailer	Car with Boat Trailer	Motor Home and Boat Trailer	Farm[3] Tractor w/One Wagon
Symbol	WB-17	WB-19*	WB-20**	WB-20D	WB-30T	WB-33D*	MH	P/T	P/B	MH/B	TR/W
Minimum Design Turning Radius (m)	13.7	13.7	13.7	13.7	13.7	18.3	12.2	10.1	7.3	15.2	5.5
Centerline[1] Turning Radius (CTR) (m)	12.5	12.5	12.5	12.5	12.5	17.1	11.0	9.1	6.4	14.0	4.3
Minimum Inside Radius (m)	5.6	2.4	1.3	5.9	3.0	4.5	7.9	5.3	2.4	10.7	3.2

Note: Numbers in table have been rounded to the nearest tenth of a meter.

* Design vehicle with 14.63-m trailer as adopted in 1982 *Surface Transportation Assistance Act* (STAA).

** Design vehicle with 16.16-m trailer as grandfathered in with 1982 *Surface Transportation Assistance Act* (STAA).

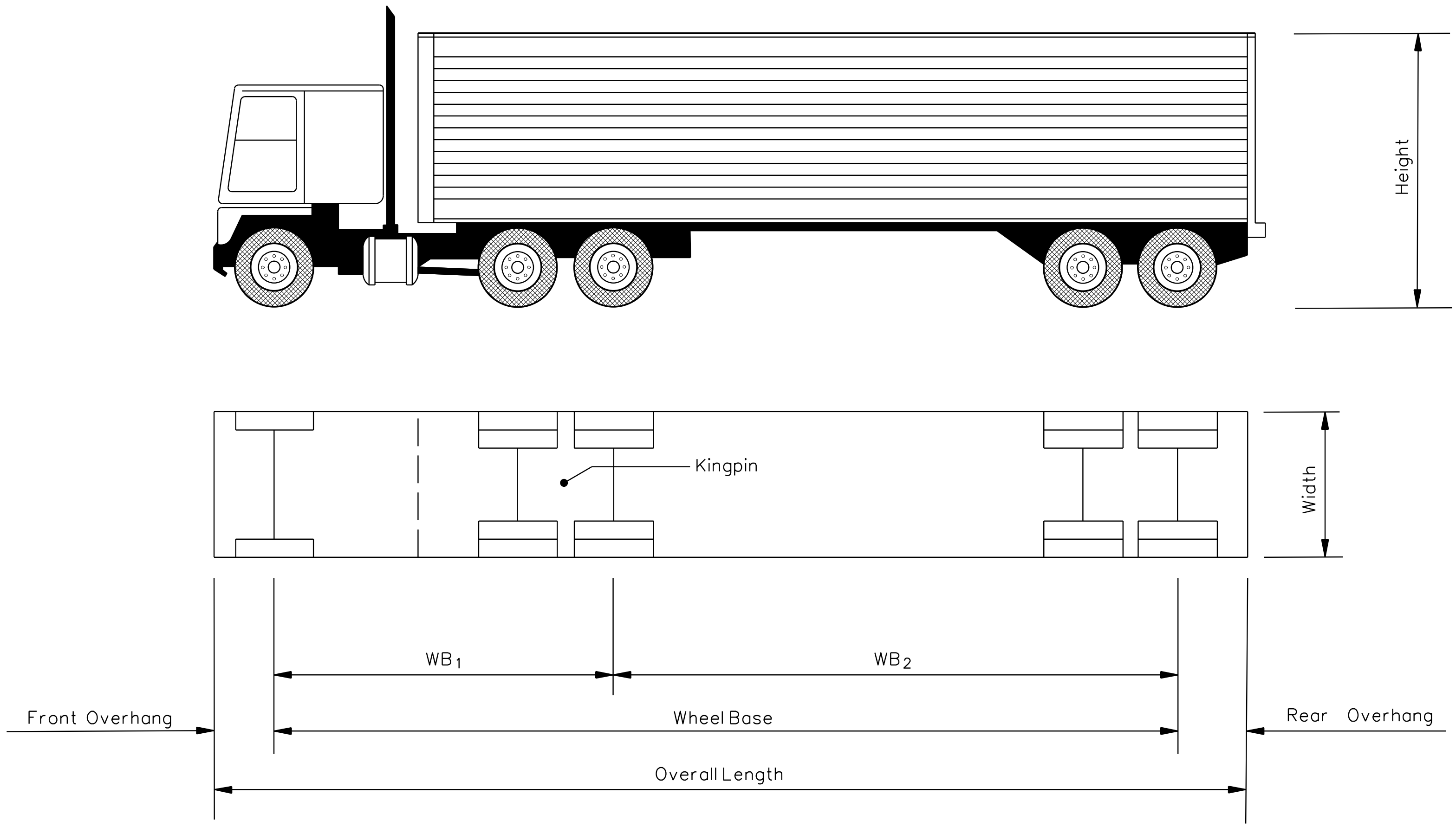
1 The turning radius assumed by a designer when investigating possible turning paths and is set at the centerline of the front axle of a vehicle. If the minimum turning path is assumed, the CTR approximately equals the minimum design-turning radius minus one-half the front width of the vehicle.

2 School buses are manufactured from 42-passenger to 84-passenger sizes. This corresponds to wheel base lengths of 3.35 m to 6.1 m, respectively. For these different sizes, the minimum design turning radii vary from 8.78 m to 12.01 m and the minimum inside radii vary from 4.27 m to 7.74 m.

3 Turning radius is for 150-200 hp tractor with one 5.64-m long wagon attached to hitch point. Front wheel drive is disengaged and without brakes being applied.

MINIMUM TURNING RADII OF TYPICAL DESIGN VEHICLES
(Metric)

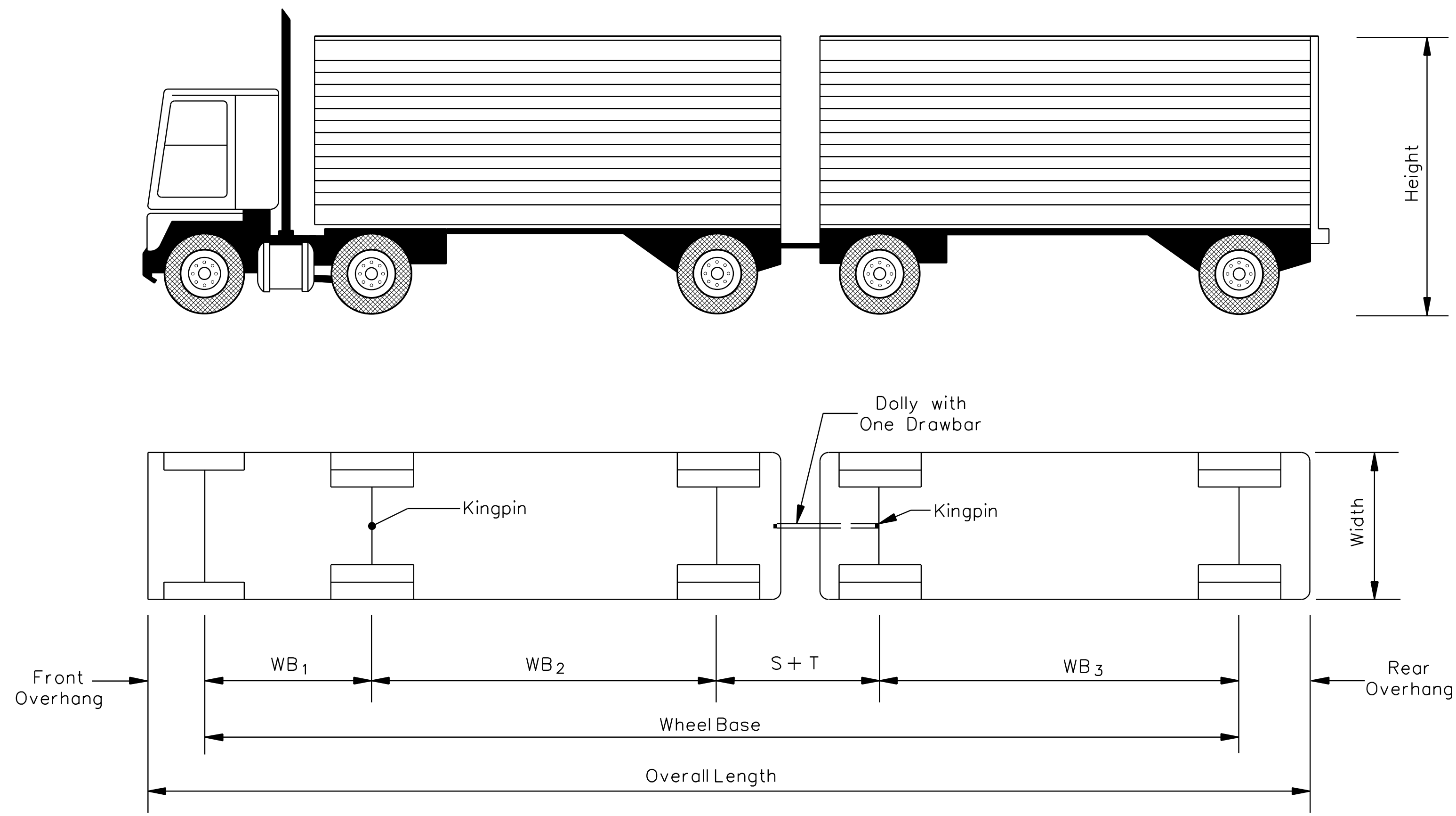
Figure 31-5.B



Note: For the legal dimensions of trucks allowed on Illinois highways, refer to information from the Central Bureau of Operations, Maintenance Operations Section.

BASIC DIMENSIONS OF TRACTOR-SEMITRAILER VEHICLE

Figure 31-5.C



Note: For the legal dimensions of trucks allowed on Illinois highways, refer to information from the Central Bureau of Operations, Maintenance Operations Section.

BASIC DIMENSIONS OF TRACTOR-SEMITRAILER/TRAILER VEHICLE

Figure 31-5.D

The *BDE Manual* presents many specific design criteria for the accommodation of pedestrians as follows:

- Chapter 17 discusses pedestrian safety.
- Chapter 58 discusses accessibility criteria.
- Chapter 48 discusses sidewalks.
- Chapter 36 discusses pedestrian accommodation at intersections.
- Chapter 56 discusses pedestrian accommodation with traffic signals.

31-5.04 Bicyclists

Similar to pedestrians, bicyclists are an important element of the highway environment. Chapter 17 discusses the detailed design criteria for bicycle accommodation.

31-6 PROJECT SCOPE OF WORK

The project scope of work will reflect the basic intent of the highway project and will determine the overall level of highway improvement. This decision, in combination with the highway functional classification (see Chapter 43), will determine which criteria in the *Manual* apply to the geometric design of the project. The following provides general definitions for the project scopes of work, and it references the applicable chapters in Part V, Highway Systems, for the design criteria based on the project scope of work.

31-6.01 New Construction

Generally, new construction is defined as horizontal and vertical alignment on a new location. The development is based on at least a 20-year design period. Typically, the project will have a significant length and will connect major termini. Where an existing two-lane, two-way facility becomes a multilane facility with a rural-type median, the new median and proposed roadway are considered new construction. In addition, new construction also includes any intersection or interchange that falls within the project limits of a new highway mainline or is relocated to a new point of intersection. Freeways, expressways, and bypasses are the typical new construction projects. Chapters 44 through 48 present IDOT criteria for new construction.

31-6.02 Reconstruction

Reconstruction of an existing highway will typically include the addition of travel lanes and/or reconstruction of the existing horizontal and vertical alignment, widening of the roadway, and flattening side slopes, but the highway will remain essentially within the existing highway corridor. These projects will usually require some right-of-way acquisitions. The primary reasons for reconstructing an existing highway are because the facility cannot accommodate its current or future traffic demands, because the existing alignment or cross section is deficient, and/or because the service life of the pavement has been exceeded. In addition, any intersection that falls within the limits of a reconstruction project will be reconstructed as needed.

Because of the significant level of work for reconstruction, the design of the project generally will be determined by the criteria for new construction based on a 20-year design period. However, some existing cross section elements may be allowed to remain in place. Chapters 44 through 48 will apply to reconstruction projects.

31-6.03 3R Projects (Non-Freeways)

3R projects (rehabilitation, restoration, and/or resurfacing) on non-freeways are primarily intended to extend the service life of the existing facility and to enhance highway safety. In addition, 3R projects should make cost-effective improvements to the existing geometrics, where practical. 3R work on the mainline or at an intersection is typically work within the existing alignment. However, right-of-way acquisition is sometimes justified for flattening slopes, changes in horizontal alignment, changes in vertical profile, and safety enhancements.

The overall objective of a 3R non-freeway project is to perform work necessary to return the highway to a condition of acceptable structural and/or functional adequacy. 3R projects may include any number of the following types of improvements:

- providing pavement resurfacing, rehabilitation, and/or short sections of pavement reconstruction;
- providing lane and/or shoulder widening (without adding through lanes);
- adding a two-way, left-turn lane (TWLTL);
- providing intersection improvements (e.g., adding turn lanes, flattening turning radii, channelization, corner sight distance improvements);
- flattening a horizontal or vertical curve;
- adding auxiliary lanes (e.g., truck-climbing lane);
- converting an existing uncurbed urban street into a curbed street;
- widening and/or resurfacing parking lanes;
- upgrading at-grade railroad crossings;
- rehabilitating and/or widening existing bridges;
- upgrading guardrail and other roadside safety appurtenances to meet current criteria;
- adjusting the roadside clear zone;
- flattening side slopes;
- providing drainage improvements, including pump stations; and/or
- implementing improvements to meet the Department's accessibility criteria (e.g., sidewalks, sidewalk curb ramps).

Any of the above may also be an element of work for a reconstruction project. Chapter 49 presents IDOT criteria for the design of 3R non-freeway projects.

31-6.04 <u>3R Projects (Freeways)</u>

3R projects (resurfacing, restoration, and/or rehabilitation) on existing freeways are primarily intended to extend the service life of the existing facility and to enhance highway safety. In addition, these projects should make cost-effective improvements to the existing geometrics, where practical. 3R freeway projects may include any number of the following types of improvements:

- providing pavement resurfacing, rehabilitation, and/or short sections of pavement reconstruction;
- realigning or widening an existing ramp or modifying an existing interchange;
- lengthening existing acceleration or deceleration lanes at freeway entrances and exits;
- flattening a horizontal or vertical curve;
- adding auxiliary lanes (e.g., a truck-climbing lane);
- rehabilitating and/or widening existing bridges;
- upgrading guardrail and other roadside safety appurtenances to meet current criteria;
- adjusting the roadside clear zone;
- flattening side slopes; and/or
- providing drainage improvements, including pump stations.

Chapter 50 presents IDOT criteria for the design of 3R freeway projects.

31-7 FHWA OVERSIGHT AND INVOLVEMENT

31-7.01 Background

Prior to the passage of the *Intermodal Surface Transportation Efficiency Act* (ISTEA) in 1991, the Federal-aid Highway Program had focused on the construction and improvement of four Federal-aid Systems – Interstate, Primary, Secondary, and Urban. ISTEA provided authorizations for highways, highway safety, and mass transportation for the next six years. This legislation contained major changes concerning the highway funding program. ISTEA provided for three Federal funding program categories:

- Interstate,
- National Highway System (NHS), and
- Surface Transportation Program (STP).

See Section 43-3 for a discussion on the Federal-aid funding categories.

ISTEA necessitated changes in the working relationship between the Department and FHWA, especially for the type and extent of oversight on Federal-aid projects.

Transportation Equity Act for the 21st Century (TEA-21), signed in 1998, maintains the Federal funding categories of ISTEA, but this *Act* precipitated further changes in Federal oversight actions on State highway projects.

Safe, Accountable, Flexible, Efficient Transportation Equity Act — Legacy for Users (SAFETEA-LU) signed in 2005 to authorize the Federal surface transportation programs for highways, highway safety, and transit for the next five years.

Moving Ahead for Progress in the 21st Century Act (MAP-21) signed into law in July of 2012. MAP-21 streamlined Federal highway transportation programs and granted states greater project oversight with an emphasis on achieving performance measures.

31-7.02 Project Oversight Agreement

31-7.02(a) Introduction

Pursuant to SAFETEA-LU, IDOT and the Illinois FHWA Division signed *The Federal-aid Highway Program, Illinois Stewardship/Oversight Agreement* on March 27, 2009. The terms of the Stewardship/Oversight Agreement are summarized in this Section. A copy of the Agreement is provided in Appendix A, "Regulations and Guidance", of Part III "Environmental Procedures."

31-7.02(b) Stewardship Expectations

In Illinois, FHWA and IDOT have jointly administered the Federal-aid Highway Program for many years. While IDOT may assume certain project approval authorities in accordance with section 106 of title 23, United States Code (USC), FHWA is ultimately accountable for ensuring the Federal-aid Highway Program is delivered consistent with the established requirements. The first expectation by the FHWA of the authority granted to IDOT is to have confidence IDOT is implementing Federal Highway Programs in compliance with applicable laws, regulations, and policies. The second expectation is to ensure procedures are in place to systematically advance State and Federal improvement efforts.

The Federal-aid Highway Program is a State administered, federally assisted program. Therefore, IDOT has been tasked with carrying out the Federal-aid Highway Program efficiently and effectively to accomplish national, State, and local goals of maintaining and improving the national highway network throughout Illinois. The objective of these goals will improve the operation and safety, and provide for national security while protecting and improving the environment. In this capacity, IDOT is responsible for administering the federally assisted highway program activities, including projects and activities administered by local public agencies

State and Federal stewardship efforts include oversight and approval actions, as well as many day-to-day actions that are routinely performed by either or both of the parties to ensure the Federal-aid Highway Program is administered in regulatory compliance and in ways that enhance the value of the program funds.

31-7.02(c) Role/Expectations of IDOT

The Federal-aid Highway Program sets design standards for the National Highway System (NHS) and the Interstate system, which is part of the NHS. These design standards must be met regardless of funding source, unless a design exception is approved. IDOT will document design exceptions when necessary and seek FHWA approval as shown in Figure 31-7.A.

On Federally funded projects where a local unit of government has the lead, IDOT will be involved with these projects to ensure requirements are met. When IDOT delegates the authority for design and construction activities to these public agencies, IDOT retains responsibility for the appropriate use of Federal funds. On federally funded projects where IDOT has the lead, IDOT will oversee the design and construction of the projects. IDOT will also ensure federally funded design and construction are properly procured.

On projects with full FHWA involvement, IDOT will invite FHWA participation in all project activities in accordance with Figure 31-7.A. During the design phase, IDOT will submit, at a minimum, draft plans and specifications to FHWA at the Preliminary, Pre-Final, and Final plans stages for FHWA's review.

For all other Federal-aid projects, IDOT will assume all responsibilities in accordance with section 106 of title 23, USC. This applies to all design activities; plans, specifications, and estimates (PS&E) approvals; concurrence in awards; and all construction and maintenance activities. This precludes the need for any FHWA approval or concurrence, except for those actions that require FHWA approval outside of title 23, USC (e.g., NEPA, Title VI of the *Civil Rights Act, Fair Housing Act*, or *Uniform Relocation Assistance and Land Acquisitions Policies Act*).

Oversight	NHS: Interstate (IR) and non-IR				City of Chicago (NHS & Non-NHS)	Non-NHS
	Full Involvement	Exempt or Programmatically Approved	Preventive Maintenance	State-Funded Projects	Exempt (Full Involvement by Agreement)	Exempt (Full Involvement by Agreement)
Governing Policy	**FHWA Policy**	**FHWA Policy with Approval Delegated to, or Documented by, IDOT**	**FHWA Policy with Approval Actions Delegated to IDOT**	**State Policy FHWA Design Standards**	**FHWA Policy with Approval Actions* Delegated to IDOT**	**State Policy***
FHWA ACTION						
Environmental Approval	Required			N/A	Required	
Structure Type, Size and Location (TSL) Approval	Required	IDOT**	Not Required	IDOT	IDOT**	IDOT**
Design Report Approval	Required	IDOT	Not Required	IDOT	IDOT*	State Policy and Procedures*
Level 1, IR Exceptions	Formal Submittal	Formal Submittal	Not required for retention of existing conditions	Formal Submittal		
Level 2, IR Exceptions	At Coordination Meeting	At Coordination Meeting		At Coordination Meeting		
NHS, non-IR Exceptions	IDOT*	IDOT		IDOT		
Preliminary, Pre-final and Final Plan Review	Required	Determine at Coordination Meeting	IDOT	N/A		
PS&E Approval	Required	IDOT	IDOT	N/A		
Authorization	Required			N/A	Required	
Bid Review Concurrence in Award	Required	IDOT	IDOT	N/A	IDOT*	State Policy and Procedures*
Change Order Approval	Required – Advance Approval for Major Changes***	IDOT Except scope or termini changes and payment of premium pay or escalated prices	IDOT Except scope or termini changes and payment of premium pay or escalated prices	IDOT	IDOT*	
Claims	Required					
Time Extension	Required				IDOT*	
Materials Certification	Required	IDOT	IDOT	IDOT Procedures	IDOT*	IDOT Procedures*
FHWA Project Inspection	Inspections and considered in joint process review sampling	Considered in joint process review sampling	Considered in joint process review sampling	Considered in joint process review as agreed by IDOT	Considered in joint process review sampling ****	Considered in joint process review sampling ****
Final Inspection	IDOT			N/A	IDOT	N/A

* With FHWA input and concurrence if Full FHWA Involvement.
** FHWA approval of the TS&L is required for a major or an unusual structure.
*** Major Change ≥ $100,000 or Major Change (see Current Construction Memorandum xx-4).
**** Inspections will be conducted for projects with Full FHWA involvement.

FHWA PROJECT OVERSIGHT ACTIONS

Figure 31-7.A

Project level actions are summarized in Figure 31-7.A. IDOT will ensure the appropriate approvals are obtained and the appropriate documentation is submitted to FHWA. For all Federal-aid projects on the NHS, IDOT will conduct all final inspections in lieu of FHWA to ensure the work was completed in substantial conformance with the approved PS&E.

IDOT will process payments to contractors, consultants, sub-recipients, and IDOT itself, to be reimbursed with Federal funds, in accordance with approved procedures and will conduct audits to ensure the accuracy of these payments.

IDOT will continue to participate in the joint IDOT/FHWA process review program to identify and implement process improvements, to promote identified best practices, and to validate conformity with requirements.

31-7.02(d) FHWA Oversight

The flexibility in designating full FHWA involvement projects under the Stewardship/Oversight Agreement will result in the need to delineate the projects more clearly. The FHWA will provide IDOT with a project list on an annual basis within six weeks after the publication of the IDOT multi-year program. The IDOT will review FHWA's list of projects with full Federal involvement and IDOT will either concur or resolve any discrepancies with FHWA involvement. The following identifies FHWA's oversight roles:

1. <u>Full Involvement Projects</u>. FHWA seeks to retain full involvement on projects with significant national interest, substantial impact to transportation and communities, and projects with opportunity to add the greatest value through FHWA's direct involvement.

    a. <u>4R Interstate Projects</u>. By authorizing legislation, FHWA is to designate 4R projects on the Interstate with construction costs greater than $1 million as projects with full involvement. Illinois defines 4R projects as shown in Figure 31-7.B.

        Some 4R projects can be determined as Inherently Low-Risk Oversight Projects on the Interstate System and IDOT can request prior approval on these projects by FHWA as delineated in the Programmatic Agreement (see Appendix B of the *Illinois Stewardship/Oversight Agreement*). IDOT can make this request either at the district coordination meeting or by letter. FHWA may suggest a 4R project be covered under the programmatic agreement, but it is IDOT's responsibility to make the request. IDOT will document the applicable project activities as if they were seeking FHWA approval, and this documentation will verify the action meets the conditions of FHWA's prior approval. No additional coordination with FHWA, or prior concurrence from FHWA, will be necessary to continue implementation of these projects.

    b. <u>Other Interstate Rehabilitation</u>. Large or complex Interstate Rehabilitation (3R) projects may be designated as projects with full involvement when there is an agreement between the FHWA Transportation Engineer, IDOT District Project Engineer, and the Central Office Design and Environment Field Engineer.

c. Non-Interstate Projects. Large or complex non-Interstate projects may be designated as projects with full involvement upon agreement by FHWA Transportation Engineer, IDOT District Project Engineer, and the Central Office Design and Environment Field Engineer or the Central Bureau of Local Roads and Streets Project Development Engineer for a local agency project. Examples include projects using experimental contract procedures, construction of major or unusual bridges, projects of national significance, NHS projects on new alignment, and major urban projects on new alignment.

2. Involvement on Other Projects. FHWA may become involved with any Federal-aid funded project, including those for which IDOT has the full project oversight responsibility. In general, FHWA involvement on these projects will be through program level activities (e.g., joint process reviews), answering specific inquiries, or resolution of specific issues.

The FHWA may also request other non-interstate Federal-aid projects have full involvement, but it is IDOT's option to grant or deny the request, although a denial would not prohibit FHWA from looking at any aspect of the project as it is implemented.

<table>
<tr><th rowspan="2"></th><th colspan="3">Project Category</th></tr>
<tr><th>Preventive Maintenance</th><th>3R</th><th>4R</th></tr>
<tr><td rowspan="2">Pavement</td><td>Thin Overlays</td><td rowspan="2">Structural Overlays</td><td rowspan="2">Pavement Replacement</td></tr>
<tr><td>Pavement Patching</td></tr>
<tr><td rowspan="2">Bridge</td><td>Deck Patching</td><td>Deck Overlay/Replacement</td><td>Superstructure Replacement</td></tr>
<tr><td>Substructure Repair
Superstructure Painting</td><td>Rail Replacement (incl. minor deck widening)</td><td>Substructure widening that adds a lane width or more</td></tr>
<tr><td rowspan="2">Traffic Operations</td><td rowspan="2">Pavement Marking and Signing</td><td>Traffic Operation and Safety Projects</td><td>Interchange Reconstruction</td></tr>
<tr><td>Add Auxiliary Lanes</td><td>Add Through Lanes</td></tr>
</table>

Note: For projects with a combination of 3R and 4R activities, the category with the majority (i.e., greatest cost) of work will govern.

PROJECT CATEGORIES

Figure 31-7.B

31-7.02(e) Control Documents

Control documents establish project development or project implementation procedures and are incorporated into project contract documents. Adherence will be made to the following IDOT control documents in the development and administration of Federal-aid projects:

- *Bureau of Design and Environment Manual,*
- *Land Acquisition Policies and Procedures Manual*,
- *Construction Manual,*
- *Manual for Materials Inspection – Project Procedures Guide*,
- *Standard Specifications for Road and Bridge Construction,*
- *Bureau of Operations Traffic Policies and Procedures Manual,*
- *Illinois Manual on Uniform Traffic Control Devices*,
- *Highway Standards,*
- *Bridge Manual,*
- *Bureau of Local Roads and Streets Manual*,
- *Water Quality Manual*,
- Disadvantaged Business Enterprise (DBE) Plan,
- Title VI Plan,
- Affirmative Action Plan,
- *Civil Rights Procedures Manual*, and
- Procedural Memoranda.

FHWA's review and approval of changes to control documents is a program-level review activity. Prior to implementation of changes in the above documents, IDOT will make the updated changes available to FHWA for review and comment and/or approval as appropriate. Only changes that relate to the controlling laws, regulations, and policies, under which the Federal Aid Highway Program must be delivered, require FHWA approval. FHWA's review of the *Standard Specifications for Road and Bridge Construction* will be through participation on the Specification Committee. The application and implementation of procedures established in the control documents may be reviewed on a program-level as part of the joint FHWA/IDOT process review program.

31-7.02(f) Laws and Regulations

IDOT will follow all applicable regulations, including, but not limited to the following:

- Title 23, United States Code – Highways,

- 23 CFR – Code of Federal Regulations Highways,

- 49 CFR Part 26 – Participation by Disadvantaged Business Enterprises in Department of Transportation Financial Assistance Programs,

- The *Federal Managers' Financial Integrity Act* of 1982,

- *A Policy on Geometric Design of Highways and Streets* – AASHTO (*Green Book*),
- *A Policy on Design Standards – Interstate System* – AASHTO,
- *Manual on Uniform Traffic Control Devices* (MUTCD), and

  Highway Safety Design and Operations Guide 1997 – AASHTO (*Yellow Book*).

31-8 ADHERENCE TO DESIGN CRITERIA

Parts IV, V, and VI of the *BDE Manual* (Roadway Design Elements, Design of Highway Types, and Other Highway Design Elements, respectively) present a vast amount of design criteria for application on individual projects. In general, the designer is responsible for making every reasonable effort to meet these criteria in the project design. However, it will not always be practical to meet the criteria. Therefore, this section presents IDOT's procedures for the appropriate action when the design criteria are not met.

31-8.01 Department Intent

The general intent of the Illinois Department of Transportation is that all design criteria in Parts IV, V, and VI be met and that, wherever practical, the proposed design should exceed the lower criteria. In addition, where a range of values is presented, the designer should make every reasonable effort to provide a design that is near the desirable or preferred value. This is intended to ensure that the Department will provide a highway system that meets the transportation needs of the State and provides a reasonable level of safety, comfort, and convenience for the traveling public.

31-8.02 Design Criteria Checklist

The "Design Criteria Checklist" (Form BDE 3108) was created to ensure designers have considered the relevant design criteria and evaluated the need for design exceptions. This checklist must be completed for each new construction, reconstruction, or 3R project. The checklist is then included in the Phase I engineering report and becomes a part of the permanent project file. The results from the checklist should also be discussed at the district coordination meetings.

31-8.03 Hierarchy of Design Criteria

The design criteria in the *BDE Manual* have varying levels of importance. Therefore, the Department has established the following hierarchy of importance for the criteria.

31-8.03(a) Level One Design Exceptions

Level One design exceptions involve the controlling design criteria established by FHWA. These criteria are judged to be those design elements that are the most critical indicators of a highway's safety and its overall serviceability. There are 13 Level One design criteria and they are listed in the "Design Criteria Checklist". IDOT uses its district coordination meetings for discussing, evaluating, documenting, and/or approving design exceptions to Level One criteria. See Section 31-8.04.

31-8.03(b) Level Two Design Exceptions

Level Two design exceptions involve other important indicators of a highway's safety and serviceability but they are not considered as critical as exceptions to the Level One criteria. When Level Two criteria are not met, the designer must discuss these at the district coordination meetings. Usually, less detailed documentation is needed to justify the decision. The Level Two design criteria are listed in the "Design Criteria Checklist".

31-8.03(c) ADA Accessibility Criteria – Maximum Extent Practicable

Chapter 58 presents most of the accessibility criteria applicable to an IDOT project and references their sources, which include: the 2010 ADA Standards for Accessible Design, the Public Rights-of-Way Accessibility Guidelines, and the Illinois Accessibility Code. These codified standards and guidelines have the effect of law and as such, design exceptions in the traditional sense, are not possible. That being said, the standards do recognize that in certain situations (e.g. alterations of existing facilities) full compliance will not always be possible within the scope of the project. Where accessibility requirements cannot be fully met, the barriers to full compliance must be well documented as well as the measures taken to comply with the standards to the maximum extent practicable. See Section 31-8.04(c) for more information.

31-8.04 <u>Design Exception Process</u>

31-8.04(a) General Procedures

The design exception process applies to all capital improvement projects considered new construction, reconstruction, 3R, 3P, or SMART. Design exceptions are discussed at project coordination meetings held in each district. These meetings are scheduled monthly or bi-monthly, are attended by representatives from FHWA and BDE, and allow for a timely approval process. In addition to this process, design exceptions require the completion of Form BDE 3100 "Design Exception Request – Project Identification" with attachments if needed. The approved Design Exception Request form then becomes part of the permanent project file.

During coordination meetings, the district discusses design details of projects in the annual and multi-year programs and, for each project, discusses and provides justification for the need for design exceptions to the design criteria. For projects on the National Highway System (NHS), design exceptions are evaluated for a determination by FHWA and IDOT in accordance with the FHWA/IDOT Stewardship/Oversight Agreement. A copy of the Stewardship/Oversight Agreement is in Appendix A, "Regulations and Guidance", of Part III "Environmental Procedures." For projects off the NHS, design exceptions are evaluated by IDOT.

The reason for design exceptions shall be clearly justified and documented. The justification may be presented by a combination of crash analysis, cost comparisons, level of social, environmental, and economic impacts, capacity analysis, and other relevant information as to the rationale and basis for the design exception. A benefit/cost analysis may also be included if it will help with the decision making process.

All discussions and agreements reached at the meeting and relevant to the design exception shall be documented by minutes prepared each time the project is presented and the completed Form BDE 3100. The documentation within the meeting minutes, or as an attachment to the minutes, and Form BDE 3100 shall include individually listing each design exception and the location, the justification, and whether the design exception was approved or denied by BDE and, if necessary FHWA representatives. The minutes and Form BDE 3100 shall be included in the Phase I engineering report. Safety cannot be compromised through the design exception process to meet scope/schedule/budget.

BDE and FHWA can typically inform the district, during the coordination meeting, if a design exception is denied or granted when adequate justification has been provided. Those design exceptions not approved by BDE at, or subsequent to coordination meetings, and still pursued by a District, will be forwarded by BDE to the Director of Highways/Chief Engineer and Deputy Director/Assistant Chief Engineer for an ultimate determination. Design exceptions presented to the Director will be submitted electronically documenting the requested design exception, the District's justification for the exception, and BDE comments. The Director will discuss the design exception with the Deputy Director/Regional Engineer before a final decision is made.

If the district determines that a design change involving a design exception is required after the Phase I engineering report process is complete, the proposed design change and exception must be coordinated with BDE. In order for the Regional Field Engineer to make an informed determination, the district must prepare either a memo with attachments discussing the design change and exception or discuss the proposed issue at a District coordination meeting. To expedite the process, if the issue is to be discussed at a coordination meeting, submit a short report addressing the change to the Regional Field Engineer in advance of the meeting.

31-8.04(b) Procedures for Full FHWA Involvement

Because of the Stewardship/Oversight Agreement IDOT has with the FHWA, FHWA's direct involvement in most projects is quite limited. However, design exceptions on projects with full FHWA oversight require FHWA approval. See Figure 31-7.A for direction.

Level One design exceptions on the Interstate system and on some NHS routes may require the preparation of a report and a formal request to the FHWA for determination. For Level One design exceptions on the Interstate system, and where required on NHS routes, Districts shall present the design exception and justification at the District coordination meeting for discussion and shall submit to the FHWA a formal request for design exception approval in a format directed by the FHWA.

FHWA design exception approval for Level Two design exceptions is usually determined at coordination meetings. The coordination meeting minutes usually provide the necessary documentation of the design exception and the concurrence or denial of the exception.

31-8.04(c) Procedures for Meeting ADA Accessibility Criteria to the Maximum Extent Practicable

The ADA accessibility criteria presented in Chapter 58 and the various Federal and state ADA standards are applicable whenever pedestrian access, circulation, or use is affected, or could be affected, by the project. As described in Section 58-1.01(b), newly constructed facilities and elements added to existing facilities must be fully compliant with the criteria. However, existing elements that are altered must comply with the criteria to the maximum extent practicable within the scope of the project. This typically means that alterations must also be fully compliant unless there are existing physical constraints or qualified historic facilities which make full compliance impracticable. The following steps are the procedure to go by when a feature does not fully meet accessibility guidelines, but will be built to the maximum extent practicable.

1. District Coordination Meetings. Any proposed element not able to be made fully compliant within the scope of the project shall be discussed at the district coordination meetings. The district shall complete Form BDE 3101 “Maximum Extent Practicable” and attach any supporting documentation. The FHWA and BDE representative should be able to determine, following the presentation at the coordination meeting, whether or not the element is designed to the maximum extent practicable.

2. Documentation. In addition to the general procedures for documentation listed in Section 38-8.04(a), the district shall fully document its evaluation of the non-compliant element and must clearly demonstrate that compliance is not feasible. Furthermore, the district shall document what will be otherwise done to apply the ADA standards to the maximum extent practicable. The documentation in the maximum extent practicable request will vary on a case-by-case basis; however, cost is not a factor. The completed Form BDE 3101 and any supporting documentation shall become part of the permanent project file. Include a copy of the completed Form BDE 3101 with the District’s inventory until the non-compliant element is improved to full compliance and removed from the transition plan.

Accessibility criteria must be fully considered in the initial scope of a project. As such, most, if not all, of the features in an alteration type of project should be able to be fully compliant and this is the Department’s goal. In other words, if too many requests for a Maximum Extent Practicable determination are being sought for a project, it is likely the project’s scope is too narrow and the scope must be re-evaluated.

31-8.04(d) Vertical Clearances Exceptions on the Interstate System

The integrity of the Interstate System for national defense purposes shall be maintained to meet AASHTO Policy as stated in A Policy on Design Standards - Interstate System. IDOT requires vertical clearances on new construction/reconstruction Interstate sections in rural areas and single routing through or around urban areas to be no less than 16 ft 09 in (5.1 m). The clear height of structures over other urban interstate routes shall not be less than 15 ft 00 in (4.5 meters). This clearance is required over the full roadway width (travel lanes and usable shoulders), including ramps and collector-distributor roadways within Interstate-to-Interstate interchanges.

The FHWA allows a minimum 16 ft 00 in (4.9 m) in rural areas and along the single routing in urban areas. The minimum vertical clearance in other urban areas shall be no less than 14 ft 00 in (4.3 m). The extra clearance IDOT requires allows for future overlays. The urban areas in Illinois where single routing occurs are:

- Peoria,
- Quad Cities,
- Metro-east St. Louis area, and
- the Chicago metropolitan area.

Maps of the single interstate route for these urban areas are shown in the figures in Section 44-6.

Design exceptions must be approved whenever the criteria are not met. These criteria apply whether it is a new construction project, a project that does not provide for correction of an existing substandard condition, or a project which creates a substandard condition at an existing structure.

There is a distinction between FHWA criteria and IDOT criteria for the vertical clearance over the Interstate. If the minimum clearances exceed those required by the FHWA, but are less than that required by IDOT, a design exception shall be presented as in Section 31-8.04(b) as a Level One design exception.

If the minimums required by the FHWA are not met, Form BDE 3102 must be used to request approval for substandard vertical clearances over interstate routes. Form BDE 3102 will be filled out by the District and submitted to the Illinois Division of the FHWA. The FHWA will complete the “Date to SDDCTEA,” “Response Requested by,” and FHWA contact information and forward the completed form to the Surface Deployment and Distribution Command Transportation Engineering Agency (SDDCTEA) prior to taking any action on the design exception. If the SDDCTEA does not respond within 10 working days (after receipt by SDDCTEA), it can be concluded that the SDDCTEA does not have any concerns with the proposed exception. If comments are forthcoming, the FHWA and IDOT will consider mitigation to the extent feasible.

Coordination with SDDCTEA, as discussed above, is not required for interstates in urban areas with a minimum vertical clearance of 14 ft 00 in (4.3 m) and also served by a single interstate route, however IDOT policy must be considered.

31-9 REFERENCES

1. *A Policy on Geometric Design of Highways and Streets*, AASHTO, 2011.

2. *Highway Capacity Manual 2010*, Transportation Research Board, 2010.

3. NCHRP 400 *Determination of Stopping Sight Distances*, Transportation Research Board, 1997.

4. "Stopping Sight Distance for Large Trucks," TRR 1208, Transportation Research Board, 1989.

5. FHWA Report No. FHWA-TO-81-1, *A User's Guide to Positive Guidance*, Federal Highway Administration, US Department of Transportation, 1981.

6. *Manual on Uniform Traffic Control Devices*, FHWA ATSSA, AASHTO, and ITE, 2009.

7. "Design Exceptions: Legal Aspects," TRR 1445, Transportation Research Board, 1994.

8. A Policy on Design Standards – Interstate System, AASHTO, 2005